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Malaria among Active Duty Soldiers, U.S. Army, 2001

In the U.S. military, Army soldiers operate and train in many areas of the world where malaria is endemic.[1-4] In recent years, the majority of malaria cases among U.S. soldiers were acquired in the vicinity of the Demilitarized Zone (DMZ) in Korea.[5] In calendar year 2000, nearly three-fourths of all malaria cases among soldiers were acquired in Korea; however, because many Korea-acquired cases have long incubation times, most infections of soldiers acquired in Korea were clinically manifested during subsequent assignments outside of Korea.[6] This report summarizes the malaria experience of U.S. Army soldiers during calendar year 2001.

Methods. The Defense Medical Surveillance System was searched to identify all hospitalizations and reportable medical events during calendar year 2001 with diagnoses of malaria (ICD-9-CM: 084.0-084.9). For this summary, diagnoses from hospitalizations were prioritized over those from reportable events records, and only one episode of malaria per soldier was included. Locations of malaria acquisition were estimated in a hierarchical fashion: 1) all cases diagnosed among soldiers in Korea were considered Korea-acquired; 2) cases that were documented with reports to the Reportable Medical Events System that listed exposures to malaria endemic locations were considered acquired in those locations; 3) cases assigned to Korea within 2-years of malaria diagnoses were considered Korea-acquired; 4) and all remaining cases were classified as "unknown" locations of acquisition.

Results. Fifty-two soldiers were diagnosed with malaria during calendar year 2001. Thirty-three (63%) of them were hospitalized, and one died. Male and white nonhispanic soldiers were overrepresented among malaria cases relative to their representation in the Army overall (figure 1). As well, the age distribution of affected soldiers generally reflected that of the Army overall (figure 1).

Nearly half (n=25) of all cases were considered acquired in Korea; of these, 15 were diagnosed at medical facilities in the United States or Europe (figure 2). Seventeen cases were considered acquired in Africa (figure 2). All Africa-acquired cases were treated at medical facilities outside of Africa.

In 13 cases, the malaria type was not reported. Of the others, 56% were due to *Plasmodium vivax* (primarily acquired in Korea), and 44% were due to *Plasmodium falciparum* (primarily acquired in Africa) (figure 3).

Editorial comment. There are several important findings of this surveillance update. First, there were fewer malaria cases among soldiers in 2001 than in any year since 1998. Second, the decline in cases overall was entirely attributable to a marked decline in Korea-acquired cases. Third, there were more cases due to *P. falciparum* in 2001 than in any year since 1995. The increase in *P. falciparum* cases in 2001 overall resulted from a cluster of cases acquired in west Africa. Finally, in approximately 75% of all cases, the location of infection acquisition differed from the location of clinical diagnosis. This finding emphasizes the importance of clinical awareness of malaria by primary care providers. Because of the increasing mobility of U.S. forces, providers of care to soldiers (regardless of their locations) should consider malaria in the differential diagnoses of soldiers who present with compatible clinical syndromes and histories of exposures to malarious areas.

Military personnel must be informed of the risks (and countermeasures) associated with conducting operations in malaria endemic areas. Strict adherence to all indicated countermeasures before, during, and after operating in malaria endemic areas is critical to minimizing the health and operational impacts of malaria.

Analysis and report by Garrett R. Lum, MPH, Analysis Group Army Medical Surveillance Activity.

Figure 1. Malaria cases, by gender, age group, and race/ethnicity, active duty, US Army, 2001.

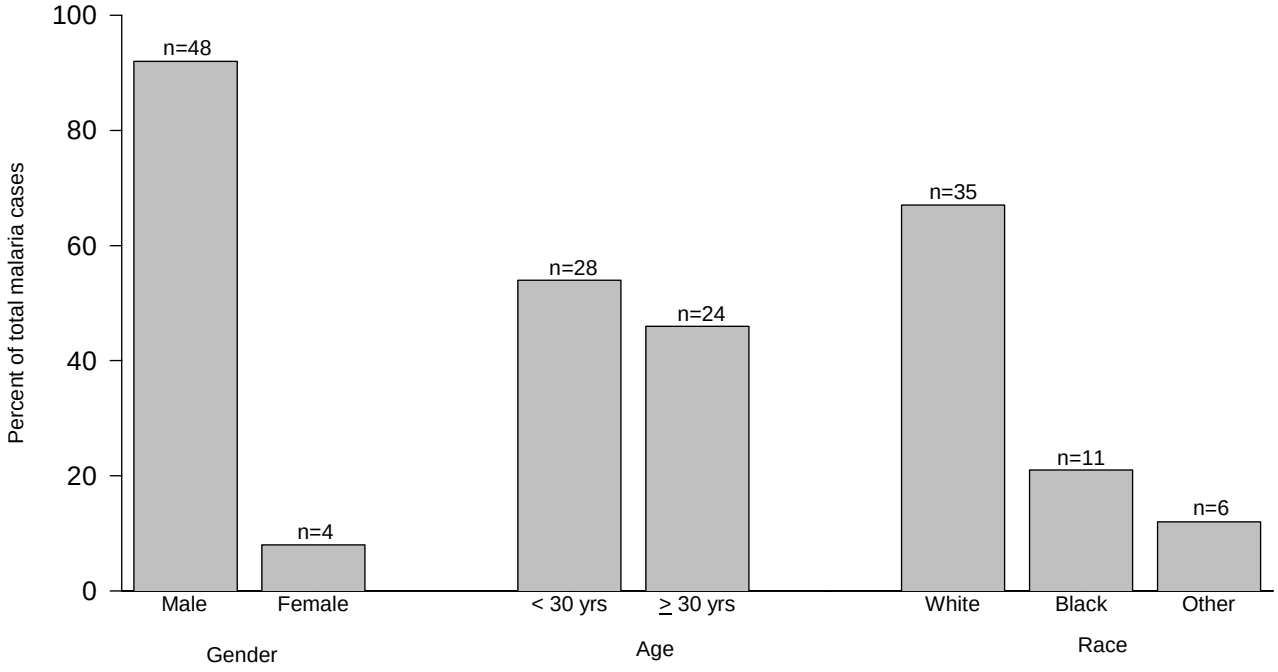
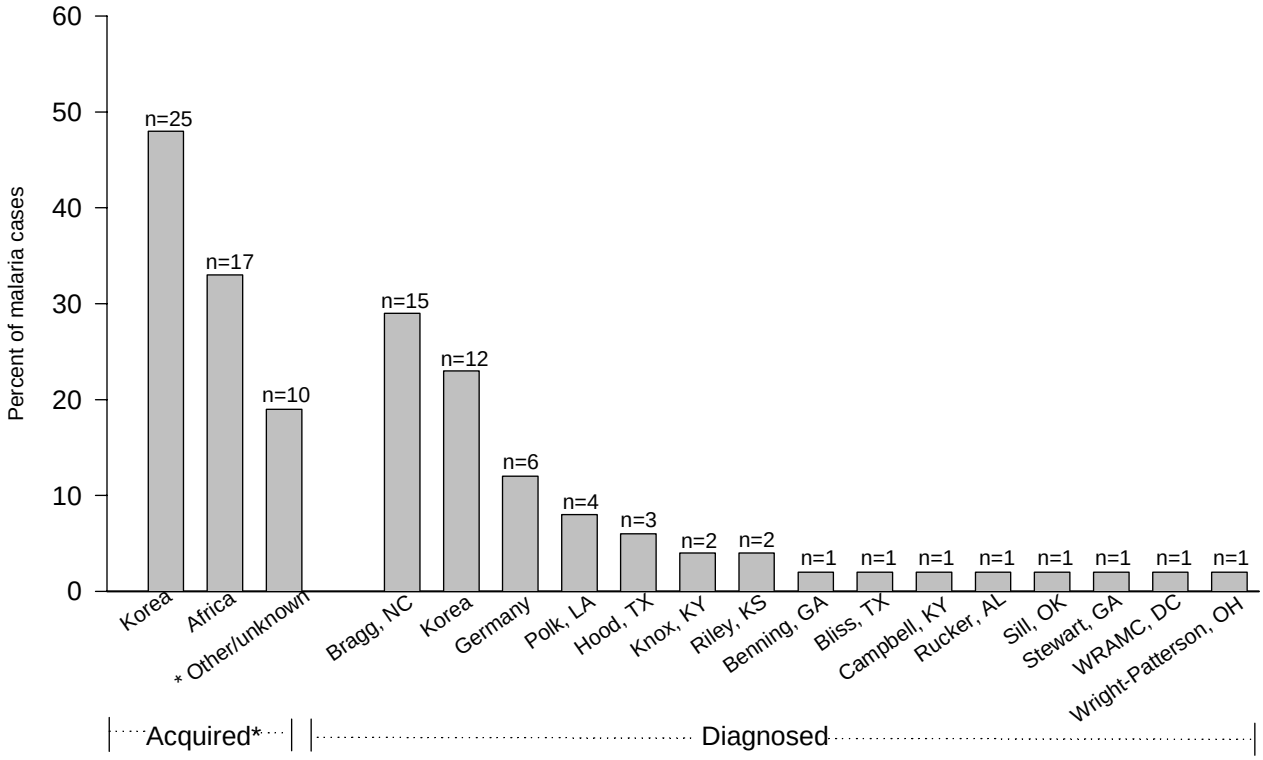


Figure 2. Number (and percent) of malaria cases, by geographical locations of acquisition and diagnosis, active duty, US Army, 2001.



* Other/unknown includes 2 cases from Latin America.

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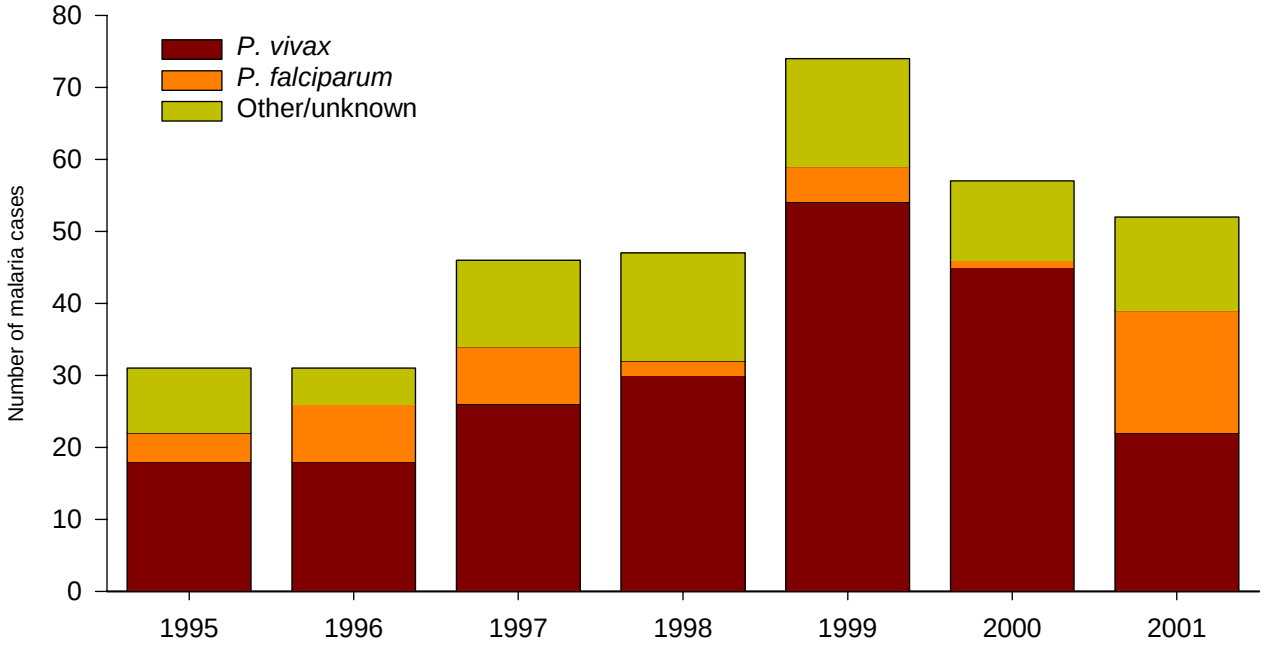
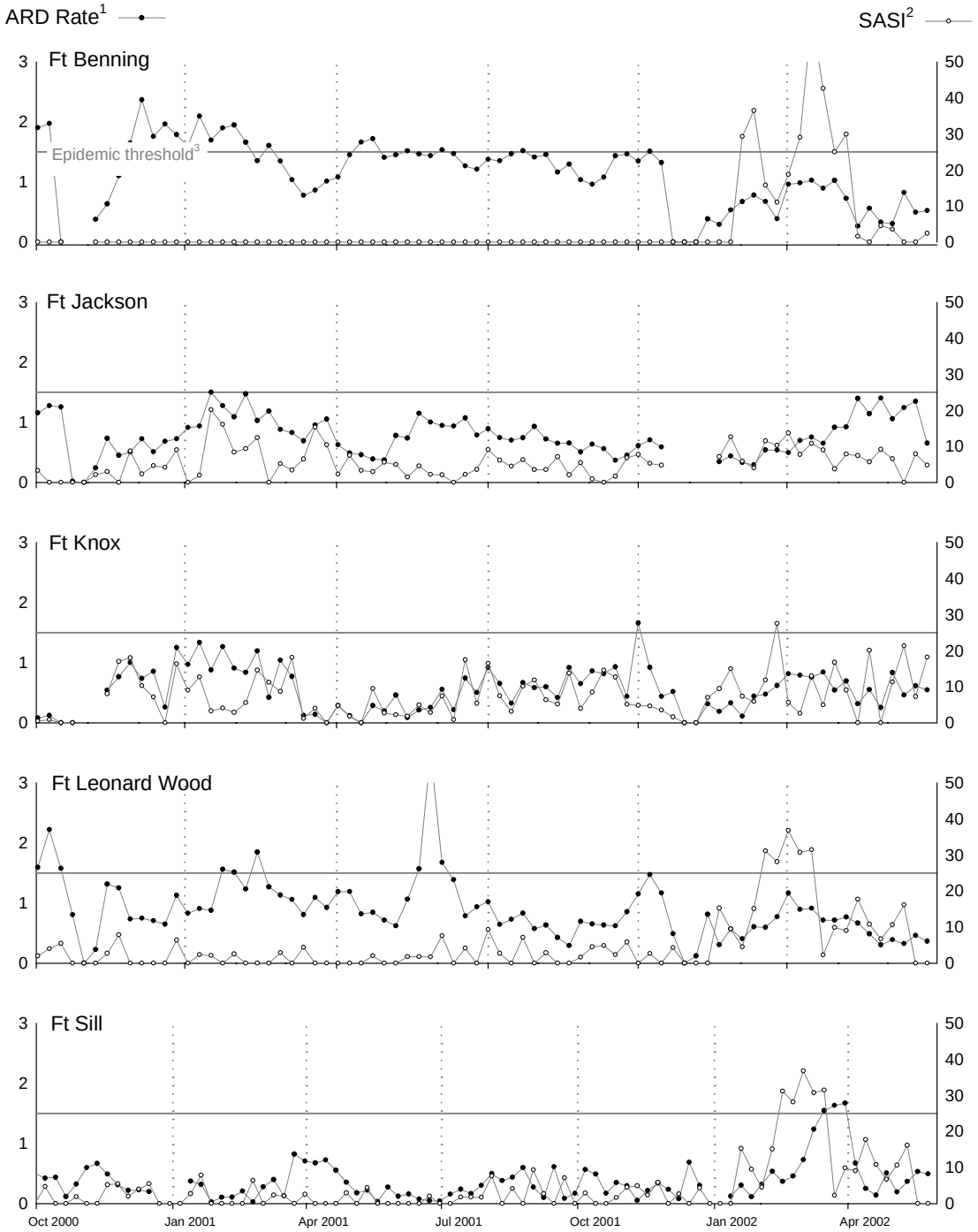
Figure 3. Malaria cases, by plasmodium species, by year, active duty, US Army, 1995-2001.



Acute respiratory disease (ARD) and streptococcal pharyngitis (SASI), Army Basic Training Centers by week through May 25, 2002



[1]ARD rate = cases per 100 trainees per week

[2]SASI (Strep ARD surveillance index) = (ARD rate)x(rate of Group A beta-hemolytic strep)

[3]ARD rate >=1.5 or SASI >=25.0 for 2 consecutive weeks indicates an "epidemic"

Sentinel reportable events for all beneficiaries[1] at US Army medical facilities, cumulative numbers[2] for calendar years through May 31, 2001 and 2002

Reporting location	Number of reports all events[3]		Food-borne								Vaccine Preventable					
			Campylo-bacter		Giardia		Salmonella		Shigella		Hepatitis A		Hepatitis B		Varicella	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
NORTH ATLANTIC																
Washington, DC Area	46	47	-	-	1	1	-	-	2	4	-	-	-	-	1	-
Aberdeen, MD	19	15	-	-	-	-	-	-	-	-	-	-	-	1	-	-
FT Belvoir, VA	25	24	1	2	1	-	-	1	-	-	-	-	-	-	-	-
FT Bragg, NC	409	681	1	2	-	-	-	1	1	1	-	-	-	1	2	-
FT Drum, NY	92	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FT Eustis, VA	72	68	-	1	-	-	1	-	-	-	-	-	-	1	1	-
FT Knox, KY	79	68	-	1	1	1	-	1	-	-	-	-	-	-	1	-
FT Lee, VA	89	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FT Meade, MD	23	27	-	-	-	-	-	-	-	-	-	-	-	-	-	1
West Point, NY	10	10	1	-	-	-	-	-	-	-	2	-	-	-	-	-
GREAT PLAINS																
FT Sam Houston, TX	89	90	-	-	1	-	-	-	-	-	-	-	-	-	-	-
FT Bliss, TX	65	42	1	-	2	1	-	-	-	1	-	-	-	1	1	-
FT Carson, CO	235	177	-	2	-	-	-	-	-	-	-	-	1	-	-	-
FT Hood, TX	422	648	1	-	-	-	-	2	-	-	-	-	1	-	1	-
FT Huachuca, AZ	11	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FT Leavenworth, KS	7	10	-	-	-	-	1	-	-	-	-	-	-	-	-	-
FT Leonard Wood, MO	73	86	-	-	-	-	-	-	-	-	-	-	-	-	5	2
FT Polk, LA	78	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FT Riley, KS	32	78	-	-	-	-	-	-	-	-	-	-	-	-	-	1
FT Sill, OK	108	88	-	1	-	-	-	-	-	-	-	-	1	-	1	-
SOUTHEAST																
FT Gordon, GA	54	50	-	-	-	-	-	-	-	-	-	-	1	-	-	-
FT Benning, GA	129	120	1	-	-	-	1	2	-	-	-	-	-	-	3	-
FT Campbell, KY	220	213	2	1	2	-	1	1	-	-	-	-	-	-	-	1
FT Jackson, SC	91	116	-	-	-	-	-	-	-	-	-	-	5	-	2	1
FT Rucker, AL	22	27	-	1	-	-	-	-	-	-	-	-	-	-	-	-
FT Stewart, GA	171	186	-	-	-	1	-	-	-	1	-	-	1	-	-	1
WESTERN																
FT Lewis, WA	242	271	1	-	-	-	2	1	-	-	-	-	1	-	-	-
FT Irwin, CA	21	16	-	-	-	-	-	-	-	-	2	-	1	-	2	-
FT Wainwright, AK	34	43	-	1	-	-	-	-	-	-	-	-	-	-	-	-
OTHER LOCATIONS																
Hawaii	204	204	10	6	3	1	1	4	2	-	-	-	1	1	-	-
Europe	469	736	8	11	-	-	8	3	-	-	-	-	2	5	6	4
Korea	15	213	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Total	**3,656**	**4,550**	**27**	**29**	**11**	**5**	**15**	**17**	**5**	**7**	**4**	**0**	**15**	**10**	**26**	**12**

1. Includes active duty servicemembers, dependents, and retirees.

2. Events reported by June 7, 2001 and 2002.

3. Seventy events specified by Tri-Service Reportable Events, Version 1.0, July 2000.

Note: Completeness and timeliness of reporting vary by facility.

Source: Army Reportable Medical Events System.

(Cont'd) Sentinel reportable events for all beneficiaries[1] at US Army medical facilities, cumulative numbers[2] for calendar years through May 31, 2001 and 2002

Reporting location	Arthropod-borne				Sexually Transmitted								Environmental			
	Lyme Disease		Malaria		Chlamydia		Gonorrhea		Syphilis[3]		Urethritis[4]		Cold		Heat	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
NORTH ATLANTIC																
Washington, DC Area	1	1	-	-	23	26	5	8	3	2	-	-	-	-	-	-
Aberdeen, MD	-	-	-	-	12	13	5	1		-	-	-	2	-	-	-
FT Belvoir, VA	-	2	-	-	17	13	4	4	-	-	-	-	-	-	-	-
FT Bragg, NC	-	-	2	1	159	475	99	94	-	-	103	64	7	-	35	42
FT Drum, NY	-	-	-	-	71	21	18	11	1	-	-	-	1	-	-	-
FT Eustis, VA	-	-	-	-	46	54	23	12	-	-	-	-	-	-	-	-
FT Knox, KY	-	-	-	-	60	51	15	12	2	-	-	-	-	-	-	1
FT Lee, VA	-	-	-	-	61	72	28	14	-	-	-	-	-	-	-	-
FT Meade, MD	-	-	-	-	17	25	6	1	-	-	-	-	-	-	-	-
West Point, NY	2	1	-	-	5	5	-	3	-	-	-	-	-	-	-	-
GREAT PLAINS																
FT Sam Houston, TX	-	-	-	-	71	73	6	10	-	-	1	-	1	-	6	-
FT Bliss, TX	1	-	1	-	41	26	14	6	-	-	-	-	-	-	2	-
FT Carson, CO	-	-	-	-	172	121	25	22	-	-	36	26	-	1	-	-
FT Hood, TX	-	-	-	1	213	340	98	160	2	-	103	133	-	-	1	4
FT Huachuca, AZ	-	-	-	-	11	15	-	3	-	-	-	-	-	-	-	-
FT Leavenworth, KS	-	-	-	-	3	8	1	2	-	-	-	-	-	-	-	-
FT Leonard Wood, MO	-	-	-	-	39	60	17	17	-	-	4	2	3	-	1	1
FT Polk, LA	-	-	-	-	59	40	16	18	-	2	-	-	-	-	-	-
FT Riley, KS	-	-	-	-	25	50	5	16	-	-	-	-	1	11	1	-
FT Sill, OK	-	-	-	-	53	56	23	12	-	-	27	18	-	-	-	1
SOUTHEAST																
FT Gordon, GA	-	-	-	-	46	40	4	7	-	-	-	-	-	-	-	-
FT Benning, GA	-	-	-	-	65	60	20	42	-	-	1	-	-	-	8	12
FT Campbell, KY	-	-	-	-	171	171	42	34	1	-	-	-	-	1	1	1
FT Jackson, SC	-	-	-	-	54	91	26	20	2	1	-	-	-	3	-	-
FT Rucker, AL	-	-	-	-	19	17	1	9	-	-	-	-	-	-	1	-
FT Stewart, GA	-	1	-	-	40	113	46	61	-	1	79	-	-	-	5	7
WESTERN																
FT Lewis, WA	-	-	-	1	145	185	31	26	-	2	57	54	4	-	-	-
FT Irwin, CA	-	-	-	-	10	9	2	7	-	-	-	-	-	-	2	-
FT Wainwright, AK	-	1	-	-	24	25	-	2	-	-	-	-	10	13	-	-
OTHER LOCATIONS																
Hawaii	-	-	-	1	159	153	24	30	-	-	1	-	-	-	-	-
Europe	1	-	-	1	368	535	65	165	1	2	-	3	8	4	-	-
Korea	-	-	1	2	4	158	6	46	1	-	-	1	-	3	2	-
Total	**5**	**6**	**4**	**7**	**2,263**	**3,101**	**675**	**875**	**13**	**10**	**412**	**301**	**37**	**36**	**65**	**69**

3. Primary and secondary.

4. Urethritis, non-gonoccal (NGU).

Note: Completeness and timeliness of reporting vary by facility.

Source: Army Reportable Medical Events System.

Serogroup C Meningococcal Disease Outbreak—Fort Leonard Wood, Missouri, 2002

Since the early 1990s, serogroup C strains of *Neisseria meningitidis* have caused more than 20 community- and organization-based outbreaks in North America[1]. Most outbreaks have been limited to 5-15 cases; however, larger outbreaks in the United States and Canada have required vaccinations of thousands to millions of individuals[2]. In the last ten years, it has become standard practice to use mass vaccination with the currently licensed quadrivalent vaccine to control epidemics of serogroup C meningococcal disease in non-military populations.

Since 1971, all new enlisted accessions to the U.S. military services have been immunized against serogroup C meningococcal disease. Since 1982, all enlisted accessions have received the quadrivalent vaccine that protects against serogroups A, C, Y, and W-135 of *N. meningitidis*. Since 1982, there have been few documented cases and no outbreaks of group C meningococcal disease among recently immunized Army trainees or active duty soldiers.

Between mid-February and late April 2002, there were five confirmed, one probable, and one suspect cases of serogroup C meningococcal disease among individuals who lived, worked, trained, and/or visited Fort Leonard Wood, Missouri. Three of the cases were among active duty servicemembers who had recently been immunized. This report summarizes the clinical courses of the cases, describes the general nature of the outbreak, and discusses the relevant factors in determining the needs for mass immunization and mass chemoprophylaxis as countermeasures.

Case definitions. For investigation purposes, a *confirmed* case was defined by either isolation of *Neisseria meningitidis* serogroup C in blood or cerebral spinal fluid (CSF) or laboratory demonstration of group C meningococcal antigen in CSF. A *probable* case was defined by the same laboratory criteria as a confirmed case, except without definitive serogroup information. A *suspect* case was defined as one that was epidemiologically linked and clinically suspicious, but was without corroborating laboratory data.

Affected community. Fort Leonard Wood is the home of the Army's engineer, military police, and chemical training schools. These schools provide advanced training to members of the Army and other Services. In addition, approximately 20,000 soldiers receive initial entry ("basic") training at Fort Leonard Wood each year. Fort Leonard Wood is located in Pulaski County in south-central Missouri. The county has a population of approximately 41,165. The resident population of Fort Leonard Wood consists of approximately 14,000 permanently assigned active duty servicemembers and their family members and approximately 8,000 temporarily assigned trainees. Approximately 5,070 civilians live in the vicinity and work at Fort Leonard Wood.

Case descriptions:

Case 1 (probable). On 17 February, three days after spending 3 to 4 hours at Fort Leonard Wood as part of a community volunteer project, a 50-year-old female developed a sore throat. On the following day, her illness progressed to fever and diffuse arthralgias; and on the next day, she had a syncopal episode associated with rapidly developing disseminated intravascular coagulation. Blood and cerebrospinal fluid (CSF) cultures were negative; however, meningococcal antigen (non-serogroup B) was demonstrated in her CSF. The patient experienced a rapid clinical descent and died on 22 February.

Case 2 (confirmed). On 27 March, a 20-year-old active duty sailor developed rapid onsets of headache, fever, and chills. The following morning, he was confused and experienced a syncopal episode. In the emergency room, he had rapidly developing purpura and gram-negative diplococci in his CSF. Cultures of his CSF and blood were both positive for *Neisseria meningitidis* C:2a:P1.5,2:L3,7 (serogroup: serotype: serosubtype: LOS type). The patient was treated and recovered without sequellae. The sailor was assigned to Fort Leonard Wood for advanced training. He had recently completed recruit training at the Naval Training Center Great Lakes, Illinois, where he had received the quadrivalent meningococcal vaccine.

Case 3 (confirmed). On 29 March, the 12-year-old child of an active duty soldier experienced headache and malaise. Early the next day, the child was brought to the emergency room complaining of nausea, vomiting, and abnormal breathing. Gram-negative diplococci were demonstrated in the child's blood, and cultures were positive for the identical subtype of serogroup C meningococci as the active duty sailor (case 2). The child died within four hours of presentation. The child resided and attended school on Fort Leonard Wood.

Case 4 (suspect). On 25 March, while traveling on spring break, a 12-year-old classmate of the child who died from meningococcemia (case 3) developed fever, sore throat, left neck pain, and rapid breathing. The child was treated for acute pharyngitis with IM penicillin and a seven-day course of oral amoxicillin/clavulanate (Augmentin®). No cultures were obtained.

Case 5 (confirmed). On 5 April, a 30-year-old female soldier in Advanced Individual Training at Fort Leonard Wood presented to the emergency room with sore throat, malaise, and syncope. Blood and CSF cultures were positive for group C *Neisseria meningitidis* (serotype identical to above). The patient was treated and recovered without sequellae. Several months earlier, the soldier had been immunized at Fort Leonard Wood with the quadrivalent meningococcal vaccine.

Case 6 (confirmed). On 7 April, the 19-year-old female spouse of an active duty solider presented to the emergency room at Fort Bragg in respiratory distress with headache, generalized body pain, decreased intake, fever, and worsening symptoms over 2-3 days. She died approximately two hours after presentation. Blood cultures were positive for group C meningococcus (strain identical to the Fort Leonard Wood outbreak strain). Her husband had completed initial entry training on 25 January 2002 at Fort Leonard Wood. She visited her then-fiancé at Fort Leonard Wood in November 2001 and moved to Fort Bragg in late February 2002. The couple were married on 5 March at Fort Bragg. Thus, this was a confirmed case of serogroup C meningococcal disease with a strain homologous to the case strains at Fort Leonard Wood. The epidemiological link between this case and those at Fort Leonard Wood is tenuous because of the long time interval between the likely exposure and the onset of illness.

Case 7 (confirmed). On 21 April, an 18-year-old sailor who was assigned to Fort Leonard Wood for advanced training presented to the emergency room with headache and other symptoms consistent with meningitis. His cerebrospinal fluid was cloudy and contained white blood cells. He was treated with antibiotics and steroids and was transferred to a nearby medical center. In mid-January, he had received the quadrivalent meningococcal vaccine prior to the start of his recruit training at the Naval Training Center Great Lakes, Illinois. Approximately three weeks prior to his illness, he had been identified as a "close contact" of case 3 and was given rifampin for prophylaxis. Antibiotic susceptibility testing failed to demonstrate resistance.

Mass immunizations/chemoprophylaxis. For purposes of intervention planning, the outbreak was considered community-based. The attack rate among the population who lived on Fort Leonard Wood was 14 per 100,000 persons. If base civilian workers were included in the at-risk population, the attack rate estimate was 11 per 100,000 persons. The Advisory Committee on Immunization Practices (ACIP) of the Centers for Disease Control and Prevention (CDC) defines an outbreak of serogroup C meningococcal disease as three or more confirmed or probable cases occurring during a period of less than or equal to 3 months resulting in a primary disease attack rate of at least 10 per 100,000 population.

A mass vaccination intervention was designed in light of the following factors: first, the attack rate exceeded the recommended action threshold; second, the current vaccine against serogroup C meningococcal disease is ineffective in children younger than two-years of age[3]; and third, the limited supply of immediately available vaccine and other logistical concerns necessitated a prioritization of vaccination within the affected community. After the first five cases, and after consultations with local, state, and CDC authorities, a mass immunization program was begun. Initially, the program targeted individuals in the community who were 2-19 years of age.

After the sixth case presented, two additional interventions were implemented: first, the targeted

age range for vaccination was expanded to 2-29 years of age; second, chemoprophylaxis of the entire Navy advanced training population (n=194, attack rate=1,025/100,000 population) at Fort Leonard Wood was undertaken as directly observed therapy in a single morning (ciprofloxacin, 500 mg single dose).

Editorial comment. This outbreak consisted of seven confirmed, probable, and suspect cases of serogroup C meningococcal disease. One confirmed case at Fort Bragg was weakly linked to the cases at Fort Leonard Wood and may represent a separate isolated incident. Three cases were trainees who had recently been immunized with the quadrivalent vaccine (one of them had also received antibiotic chemoprophylaxis). We are unaware of other serogroup C meningococcal disease outbreaks that included U.S. servicemembers who had been recently immunized.

In this outbreak, cases ranged in age from 12 to 50 years—the oldest and one of the youngest died from their infections. All of the military cases had been immunized and survived without sequellae. Epidemiologic investigations revealed links between the two sailors and the two children; however, no primary or secondary links have been identified between the other confirmed and probable cases.

The suggested prioritization of immunization in the Fort Leonard Wood community was based on age. A 19-year-old age cutoff has been used in effective interventions against serogroup C meningococcal disease outbreaks in other communities[4]. At Fort Leonard Wood, the age range was expanded in recognition of the probability of increased carriage prevalence in the general community and to include a larger percentage of the community (while considering the constraints of limited time and resources for mass immunizations). Enhanced surveillance for meningococcal disease is underway in the Fort Leonard Wood community. The effectiveness of the initial interventions will be closely monitored as vaccine supplies are replenished and delivery capacities are enhanced.

The CDC does not recommend mass chemoprophylaxis for prevention and control of community-based serogroup C meningococcal disease in most situations. This is because community populations are not fixed, and as a result, it is difficult to eradicate nasopharyngeal carriage in entire populations. If simultaneous eradication of carriage is not accomplished, then relatively rapid re-colonization is likely. However, the closed, controlled nature of the military trainee population, combined with the historical fact that mass chemoprophylaxis has been effective in the past in controlling meningococcal disease outbreaks among military trainees[5], argue that mass prophylaxis with antibiotics may be an effective strategy at Fort Leonard Wood.

Two primary cases (one of which had received rifampin prophylaxis) in vaccinated Navy advanced training students represents an extremely high attack rate in this subgroup; in turn, this represents an organization-based outbreak within the greater community-based outbreak at Fort Leonard Wood. The second Navy trainee who became ill after an appropriate prophylactic course of rifampin was most likely reinfected from a classmate rather than infected with a resistant strain of meningococcus. Ciprofloxacin has been shown to effectively clear the carriage state in a single dose regimen;[6, 7] thus it is a reasonable choice for mass chemoprophylaxis in a defined population in a closed setting. In light of the closed nature of the Navy trainee population and the remote possibility of rifampin resistance, ciprofloxacin was selected for use for mass chemoprophylaxis among the Navy trainees.

Updates of this report will be included in future MSMRs as needed.

Report and comment provided by Dennis J. Faix, LCDR (Sel), MC, USNR, Greg Martin, CPT, MC, USA, Bruno P. Petruccelli, LTC(P), MC, USA, and Robert L. Mott, MAJ, MC, USA.

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